Preface

Thin films, nanostructures, and nanocomposite materials, owing to the ability to tune their properties by controlling the size, represent a basis for the development of electronic device components for a wide range of interdisciplinary high-tech industries such as microelectronics, nanoelectronics, optoelectronics, spintronics, photonics, plasmonics, and fine mechanics. The wide implementation of low-dimensional structures is based on their unique physical–chemical properties that cannot be attained in a bulk material, this feature being crucial for satisfying the basic needs of industries in the modern world. Moreover, the combination of thin films, nanostructures, and nanocomposite materials on a common platform provides even more unique physical and multifunctional characteristics, which further stimulate their development and implementation in various fields.

Many efforts have been undertaken in the past decades to develop nanotechnologies for creating nanomaterials with determined structure and functionalities. Due to applications in spintronics, magnetic sensing, and ultrahigh-density magnetic recording, the rapidly progressing field of nanomagnetism is of particular importance. Development of new nanocomposite and nanostructured materials with novel optical, magnetic, transport, and magneto-optical properties is a key issue in this rapidly growing field. More interesting properties, effects, and possibilities for applications arise when combining the magnetism with superconductivity.

This book provides a collection of review articles from experts working in the field of nanotechnology and nanomaterials structured into 18 chapters to give an overview of recent advances in the development of thin films, nanostructured and nanocomposite materials with a detailed analysis of technologies for preparation, properties, and various applications of materials and device structures. Most chapters contain in-depth studies related to a particular nanomaterial issue, the book being therefore targeted at researchers. However, it can be useful also for Ph.D. students, graduate and undergraduate students specializing in disciplines related to solid-state nanotechnologies and nanomaterials. The chapters are grouped into three parts: the first part focuses on preparation and characterization of thin films, the

second concentrates on magnetic nanomaterials, and the third deals with nanostructured and composite materials.

The first part involves five contributions on metal/alloy-based films, nanometer oxide and hydroxide pellicles, graphite coatings, and semiconducting films of A^2B^6 compounds, including CdS, CdSe, CdTe, and ZnS_xSe_{1-x}.

In the first chapter, Cesiulis et al. present the capabilities and advantages of Electrochemical Impedance Spectroscopy (EIS) as a useful and nondestructive technique for investigating various types of thin films such as metal/alloy films, oxide films produced by anodization of metals, and organic films onto metals. The approach is overviewed from the point of view of theoretical basics and practical applications of EIS, as for instance for the characterization of biosensing surfaces and in evaluation of bioanalytical signals generated by biosensors.

In the next two chapters, Topala et al. describe the advantages, importance, and prospects of producing nanometer oxide, hydroxide, and graphite films on metal surfaces by electrical discharge pulse technologies with focus on their applications as anticorrosive coatings, for surface passivation in chemical industries, and in applications in micro- and nanoelectronics.

The contribution of Popa provides results related to the preparation and characterization of ZnS_xSe_{1-x} thin films with various x values produced by vacuum evaporation technique on glass substrates, while that of Potlog gives a review on technological methods for growing II–VI thin films and their application in four types of photovoltaic devices based on CdS/CdTe, ZnSe/CdTe, TiO_2/CdSe, and TiO_2/CdTe heterostructures.

The second part, composed of four contributions, focuses on the development of magnetic nanomaterials. Recent developments in the field of magnetoelectric effects occurring due to coupling between the ferroelectric and ferromagnetic orders, notably as a strain-mediated phenomena in piezoelectric/magnetostrictive composite materials, are presented in two chapters by Vidal et al., with special emphasis on direct and converse magnetoelectric effects in trilayers of metglas and lead-free piezoelectrics and their extensive promising applications in *AC* and *DC* vector-magnetic field sensors, current sensors, transducers, spintronic, microwave, and read/write devices. The basis for most theories related to the magnetoelectric effect in composites is described, and the experimental methods for measuring the magnetoelectric effect are identified with particular emphasis on the dynamical techniques.

Physical properties of narrow-bandgap semimagnetic semiconductors and their practical applications are reviewed in the contribution of Gheorghitza et al., while exchange bias diluted ferromagnetic alloys are described by Sidorenko et al. in the final chapter of this second part as an essential building block of spintronic devices, particularly for superconducting spintronics. In particular, the influence of a cobalt sublayer on a conventional exchange bias $CoO_x/Cu_{41}Ni_{59}$ interface is identified, and its advantages for application in superconductor-ferromagnet spin-valve heterostructures are analyzed.

Through nine chapters of the third part of this book, the reader will be familiarized with various types of nanostructured and nanocomposite materials, among

which TiO_2/WO_3 bi-layers are reviewed in the contribution from Macovei et al. by bringing new details of the local atomic ordering at the TiO_2–WO_3 interface and their relevance in designing oxidic semiconductor heterostructures for applications with enhanced photocatalytic performances.

The optical and photoelectrical properties of composite nanostructures with intercalated $A^{III}B^{VI}$ lamellar semiconductors are analyzed in three chapters by Evtodiev et al. with respect to technologies for intercalating of atoms (molecules) into $A^{III}B^{VI}$ semiconductors, polymorphism, crystal structure, electronic band structure, and prospects of their applications in photodetectors and photovoltaics.

Various manufacturing methods for obtaining nanoreliefs are reviewed in a chapter by Slatineanu, such as mechanical, electrochemical, thermal, and hybrid processes. Methods of characterization and possible applications of the produced nanoreliefs are analyzed.

Recent advances in template assisted production of nanocomposite materials with especial emphasis on the production of metal nanotubes by means of ion-track membranes, alumina templates, and semiconductor templates are reviewed in the contribution of Tiginyanu et al. with the analysis of advantages and drawbacks of different templates. Prospects of applications of metal nanotubes and nanotube-based materials in the fabrication of microelectronic and photonic devices, magnetic recording media, biomagnetics, etc., are analyzed.

The contribution of Nica et al. presents a review of phonon thermal properties of segmented nanowire with a focus on theoretical results for Si and Si/Ge structures with constant and periodically modulated cross-sections. Possible practical applications of segmented nanowires in thermoelectric energy generation are also discussed.

The results obtained in the past few years regarding THz devices based on carbon nanomaterials, such as graphene, are reviewed by Dragoman with the purpose of estimating the prospects of covering the famous THz gap by means of further development of research in the field of two-dimensional materials. Different devices and circuits based on graphene and carbon nanotubes are discussed, such as antennas operating at terahertz frequencies, generators, detectors, and mixers of terahertz electromagnetic waves.

Some elements related to abrasive flow machining (AFM), specifically state-of-the-art elements of technological systems, and equipment fabrication and characterization are presented in the chapter by Ionescu et al.

We are grateful to all the contributors who made special efforts to prepare their respective chapters, and we hope that this book will be an essential reference tool for a wide scientific community, and for libraries at universities and research institutions.

Chisinau — Ion Tiginyanu
Balti — Pavel Topala
Chisinau — Veaceslav Ursaki

http://www.springer.com/978-3-319-30197-6

Nanostructures and Thin Films for Multifunctional Applications
Technology, Properties and Devices
Tiginyanu, I.; Topala, P.; Ursaki, V. (Eds.)
2016, XXIV, 576 p. 364 illus., 296 illus. in color.,
Hardcover
ISBN: 978-3-319-30197-6